SESSION 3

ITS CABINET FAMILY

- **TRANSPORTATION ELECTRICAL EQUIPMENT SPECIFICATIONS (TEES) DOCUMENT, DATED NOV. 19, 1999 PLUS ADDENDUMS**

FLOYD WORKMON

SECTION 3.1

VERSIONS AND SYSTEMS

- TEES CHAPTERS 1, 3, 5 AND 7
- MODULAR DESIGN WITH ALL UNITS, ASSEMBLIES, CAGES AND HOUSINGS INTERCHANGEABLE

CABINET - VERSIONS

- **TRAFFIC SIGNAL APPLICATION**
  - **. MODEL 340**
  - **. MODEL 342**
  - **. MODEL 346**
- **TRAFFIC MANAGEMENT APPLICATIONS**
  - **. MODEL 354**
  - **. MODEL 356**

MODEL 340 CABINET

- HOUSING #3 / TWO CAGES #1
- J PANELS #1 AND DRAWER
- AC SERVICE ASSEMBLY
- AC POWER ASSEMBLY
- AC CLEAN POWER ASSEMBLY
- DC / CABINET COMMUNICATION ASSEMBLY
- THREE INPUT ASSEMBLIES EACH WITH AN SIU
- TWO 14 PACK (FOUR 6 PACKS) OUTPUT ASSEMBLIES EACH WITH SIU, AMU AND FTR UNITS
- PDA #5 WITH CMU, 2 FLASHERS AND TWO POWER SUPPLY UNITS

MODEL 342 CABINET

- HOUSING #1 / CAGE #1
- J PANELS #1 AND CONTROLLER SHELF
- AC SERVICE ASSEMBLY
- AC POWER ASSEMBLY
- DC / CABINET COMMUNICATION ASSEMBLY
- TWO INPUT ASSEMBLIES EACH WITH AN SIU
- 14 PACK OUTPUT ASSEMBLY WITH SIU, AMU AND FTR UNITS
- PDA #5 WITH CMU, 2 FLASHERS AND TWO POWER SUPPLY UNITS

MODEL 346 CABINET

- HOUSING #2 / CAGE #2
- J PANELS #2 AND CONTROLLER SHELF
- AC SERVICE ASSEMBLY
- AC POWER ASSEMBLY
- DC / CABINET COMMUNICATION ASSEMBLY
- INPUT ASSEMBLY WITH SIU
- 14 PACK OUTPUT ASSEMBLY WITH SIU, AMU AND FTR UNITS
- PDA #5 WITH CMU, 2 FLASHERS AND TWO POWER SUPPLY UNITS

MODEL 354 / 356 CABINETS

- MODELS 354 AND 356 ARE IDENTICAL EXCEPT AS NOTED
- HOUSING #1 / CAGE #1 (MODEL 356 UTILYZES HOUSING #2 / CAGE #2)
- J PANEL #1 AND CONTROLLER SHELF
- AC SERVICE ASSEMBLY
- AC POWER ASSEMBLY
- DC / CABINET COMMUNICATION ASSEMBLY
- INPUT ASSEMBLY WITH SIU
- 6 PACK OUTPUT ASSEMBLY WITH SIU, AMU AND FTR UNITS
- PDA #6 WITH CMU AND TWO POWER SUPPLY UNITS

CABINET COST "GUESSTIMATES"

- **MODEL 340:**

  . **PURCHASED BY HARRIS COUNTY, TEXAS $11,200 WITH 2070 LITE CONTROLLER $2100**

- **MODEL 342:**

  . **PURCHASED IN QUANTITY OF 100 UNITS / QUALIFIED PRODUCT LIST (QPL) $5K - $6K**

SYSTEM PERIPHERALS

- J PANELS
- POLICE PANEL
- VENTILATION AND CONTROL
- OPTIONS:
  - . CABINET ILLUMINATION
  - . SHELVES AND DRAWERS
  - . EXTERNAL COMMUNICATION TERMINATION ASSEMBLY (ECTA) MODULE

SESSION 3.2

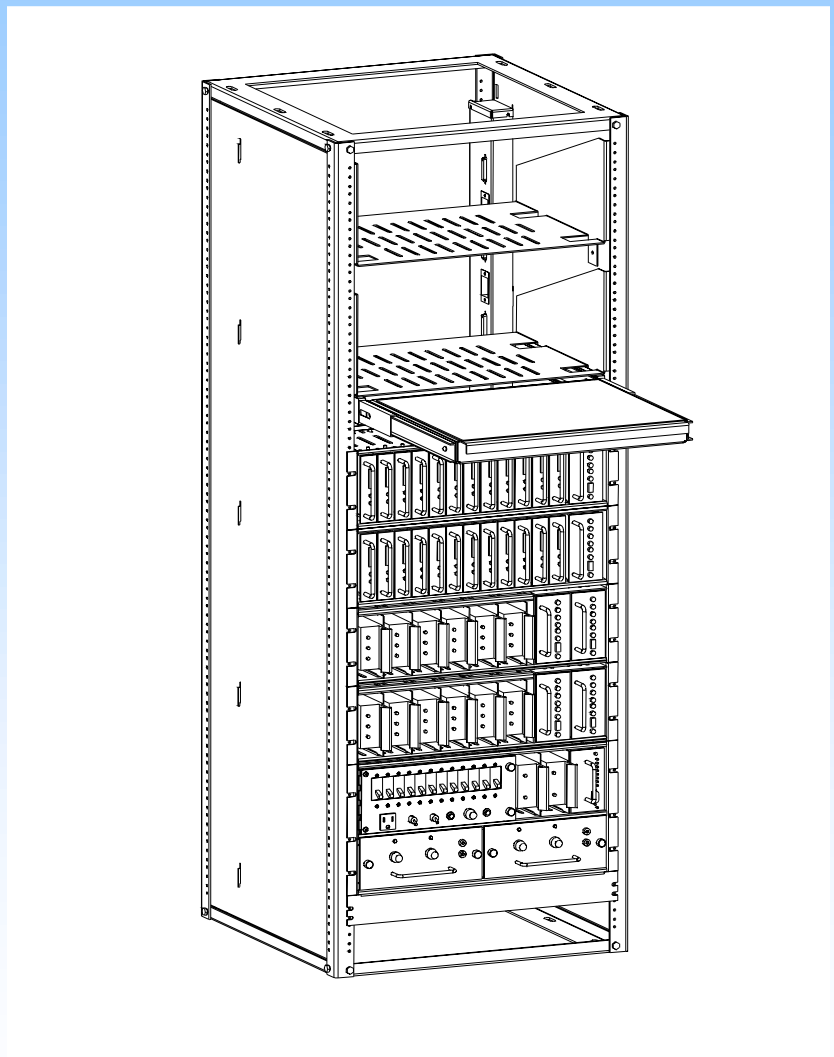
HOUSINGS, CAGES AND ASSEMBLIES

RON JOHNSON

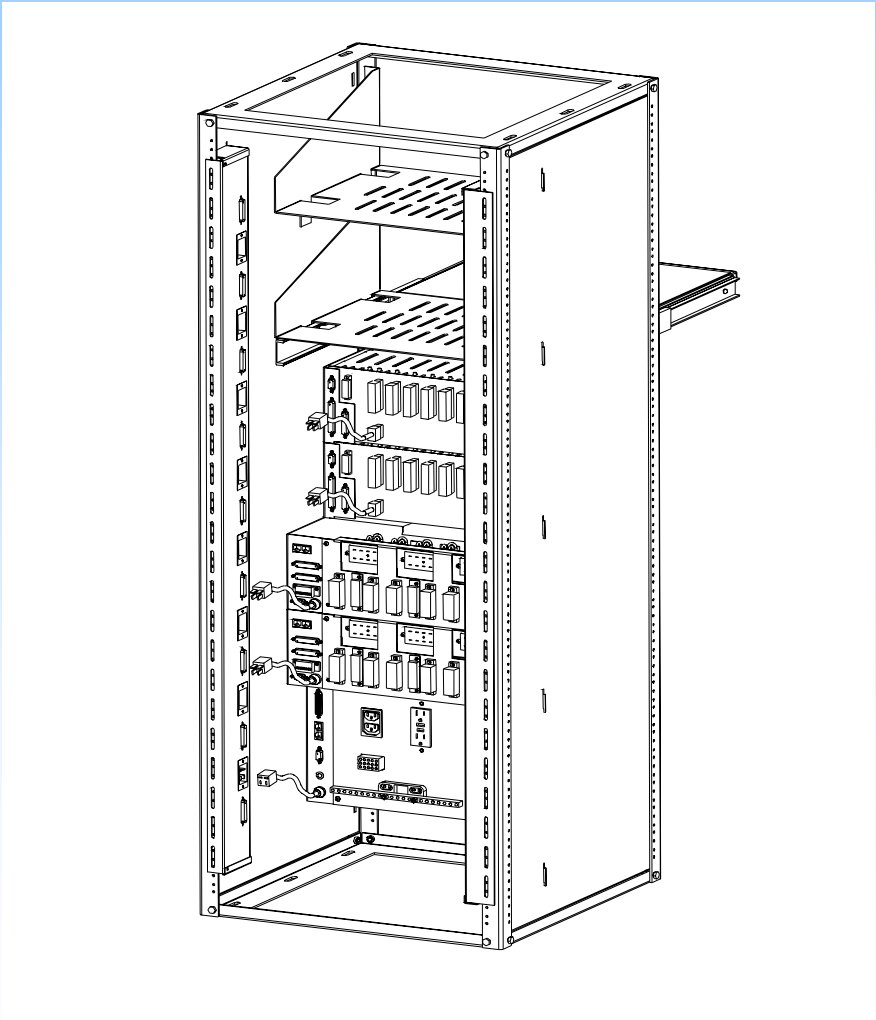
HOUSING 1

HOUSING 3

ITS CABINET CAGE ASSEMBLY



ITS CABINET CAGE ASSY



INPUT ASSEMBLY

SUPORTS TWELVE INPUT DEVICES PLUS SIU (TWO OR FOUR CHANNEL DETECTORS OR INPUT DEVICES).

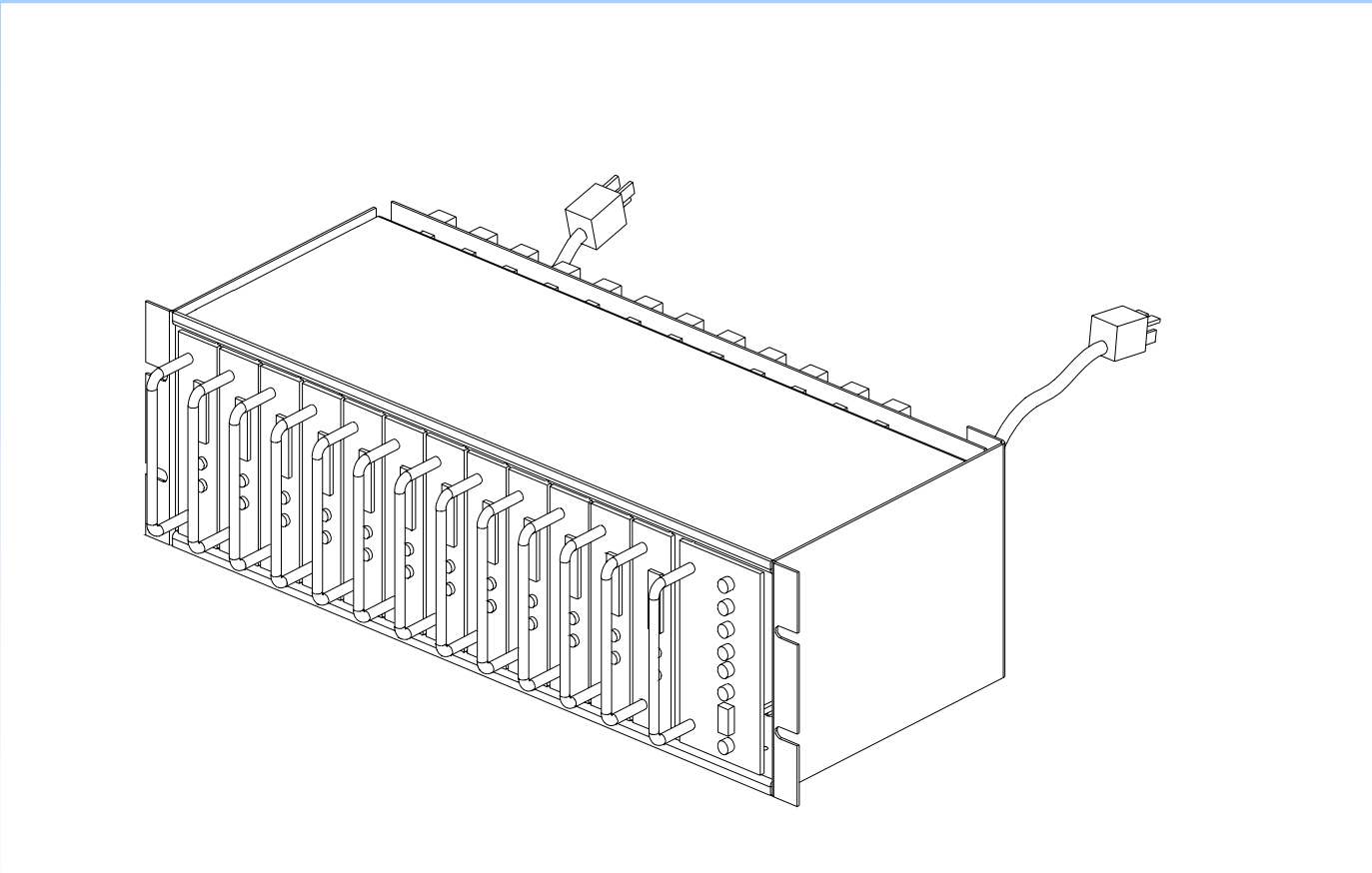
170 DETECTORS AND ISOLATORS ACCEPTED.

22 PIN DOUBLE SIDED EDGE CONNECTOR PROVIDED TO ACCOMMODATE DEVICES.

PLUGGABLE FIELD CONNECTORS FOR EASY INSTALLATION OR REMOVAL.

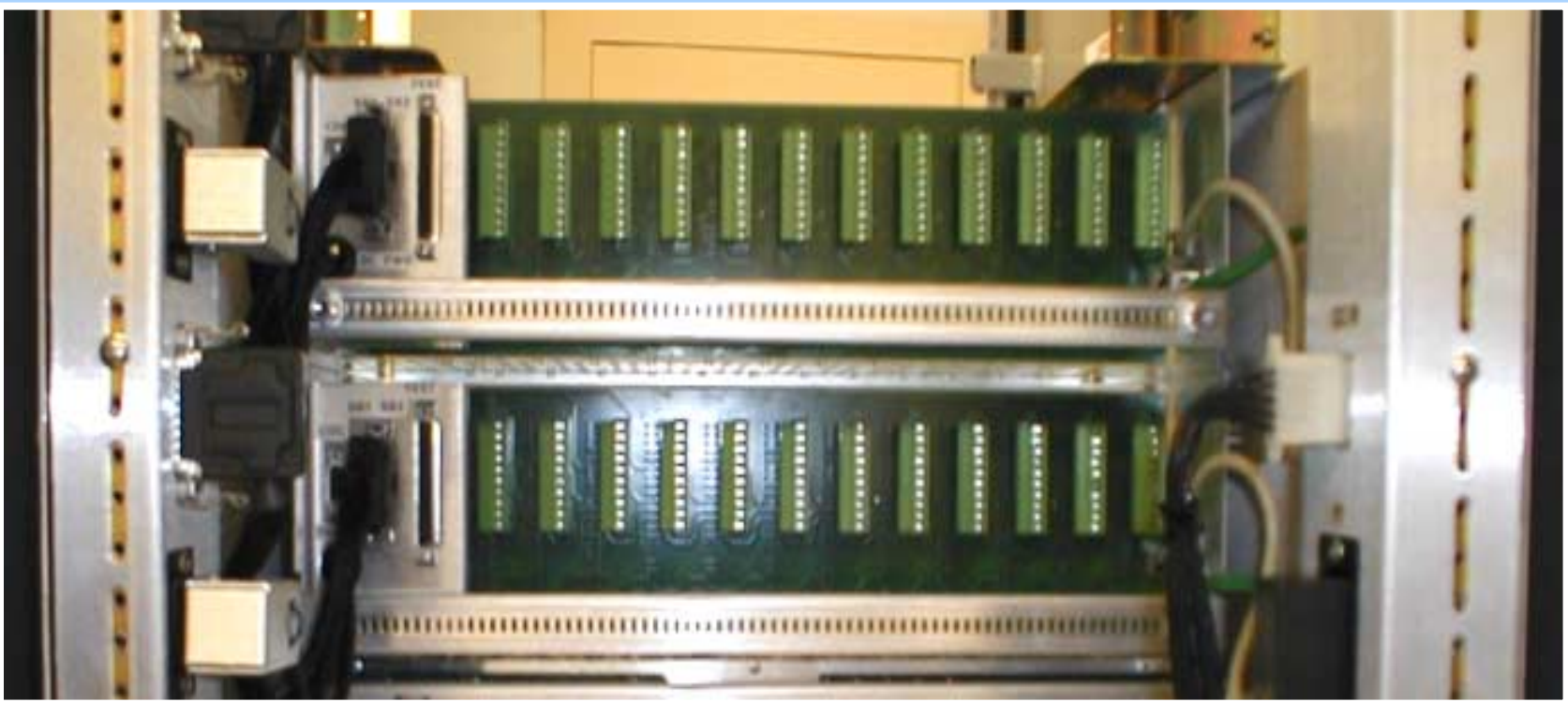
UP TO FIVE INPUT ASSEMBLIES SUPPORTED IN RACK.

INPUT ASSEMBLY



INPUT ASSEMBLY

INPUT ASSEMBLY (REAR)



6/14 PACK OUTPUT ASSEMBLIES

ACCEPTS 6 OR 14 SWITCHPACKS WITH AN AMU AND SIU.

CONTAINS THREE FLASH TRANSFFER RELAYS AND SIX FLASH PROGRAM BLOCKS FOR EACH OF THE SIX SWITCHPACKS.

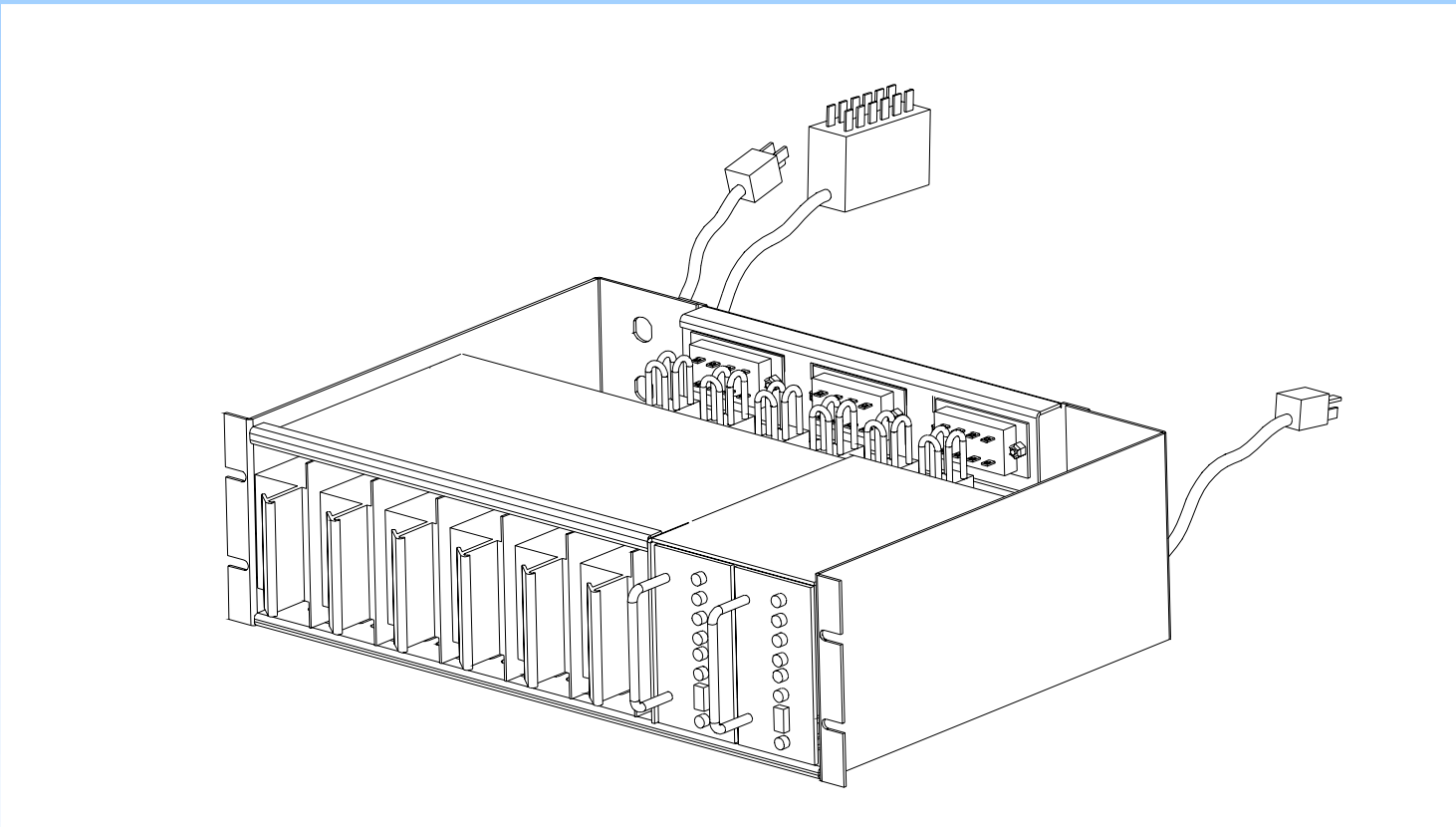
WILL CONTAIN TORROID COILS FOR CURRENT MEASUREMENT OF SWITCHPACK OUTPUT (FUTURE)

PLUGGABLE FIELD OUTPUT CONNECTORS FOR EASY REMOVAL AND INSTALLATION.

PLUGGABLE OUTPUT PROTECTION DEVICES ie. MOVISTORS

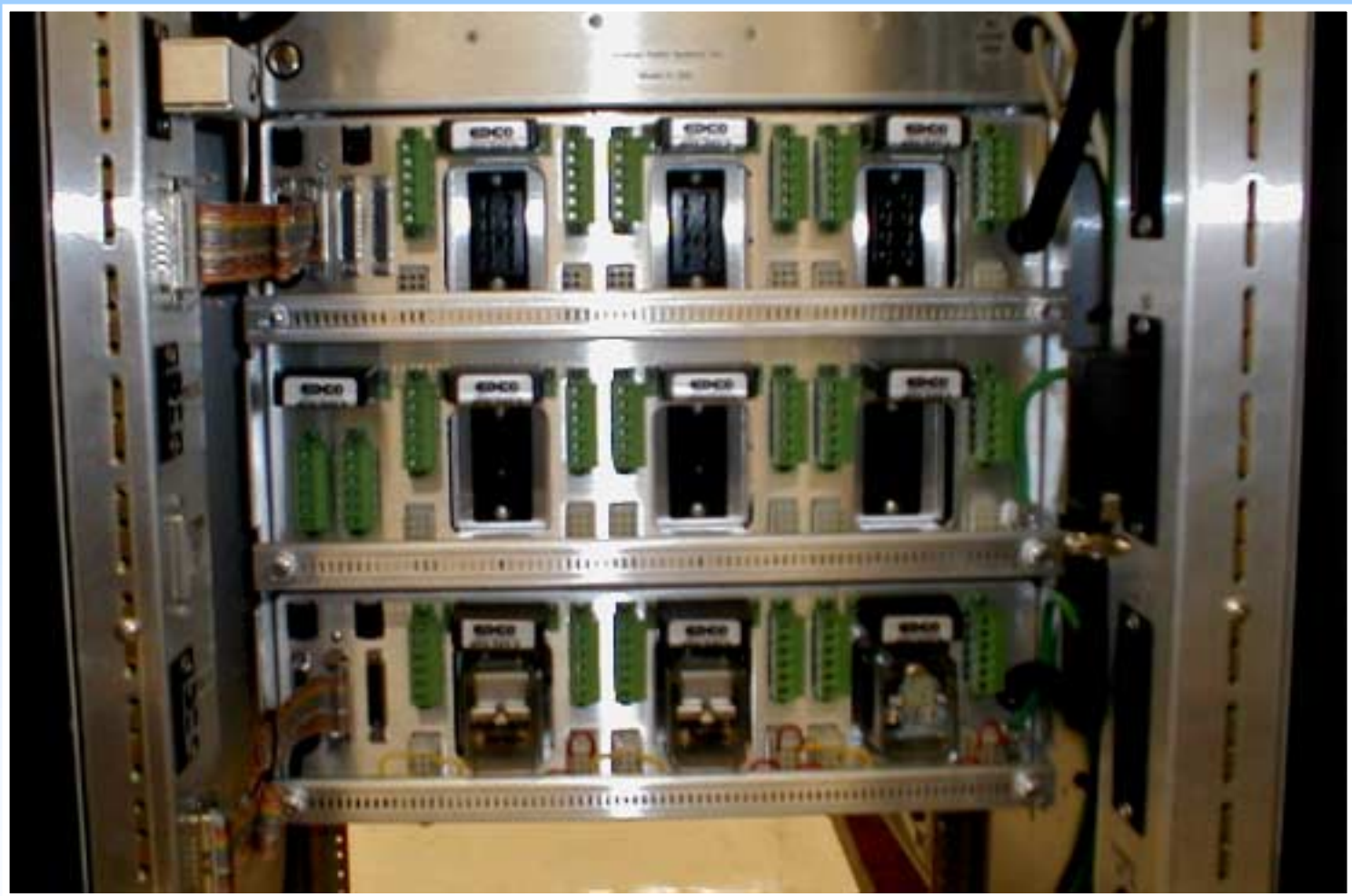
UP TO FOUR 6 PACK ASSEMBLIES OR TWO 14 PACK ASSEMBLIES ACCEPTED IN THE RACK SYSTEM.

6 PACK OUTPUT ASSEMBLY



6 &14 PACK OUTPUT ASSEMBLIES

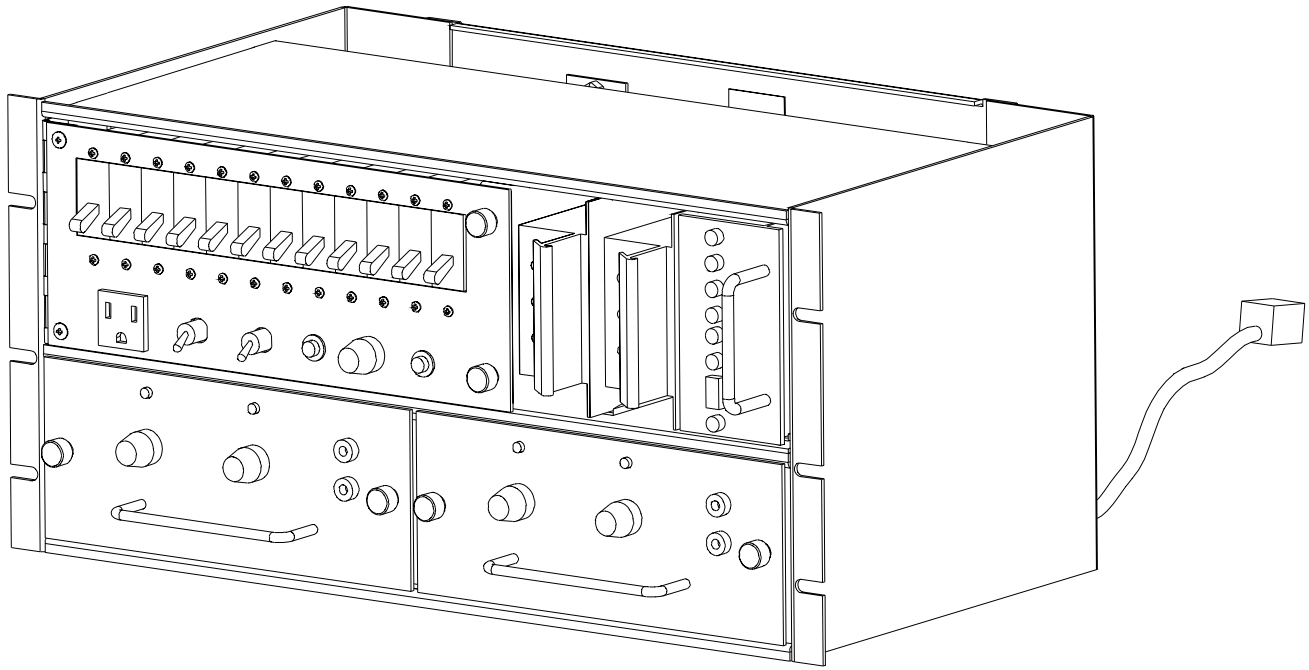
6 &14 PACK OUTPUT ASSEMBLIES



PDA 5/6

Reza Roozitalab

PDA 5



PDA 5 INSTALLED

APPLICATIONS:

PDA #5: USED FOR TRAFFIC SIGNAL CABINET APPLICATIONS (E.G., 340, 342 & 346).
PDA #6: USED IN TRAFFIC MANAGEMENT CABINET APPLICATIONS (E.G., 354).

FEATURED:
STANDARD 19” EIA RACK COMPATIBLE.
MODULAR DESIGN FOR INTERCHANGEABILITY.
FRONT DOOR ACCESS TO THE INSIDE.
HOUSES 12 & 24 VOLT POWER SUPPLIES & CABINET MONITOR UNIT (CMU).

PDA #5

FRONT INCLUDES: CIRCUIT BREAKERS, SIGNAL SWITCHES & SERVICE RECEPTACLES.

REAR INCLUDES: SERIAL BUSES, DC PLUG, AC SIGNAL POWER, CABINET CONNECTOR & SERVICE RECEPTACLE.

INSIDE INCLUDES: MERCURY CONTACTOR.

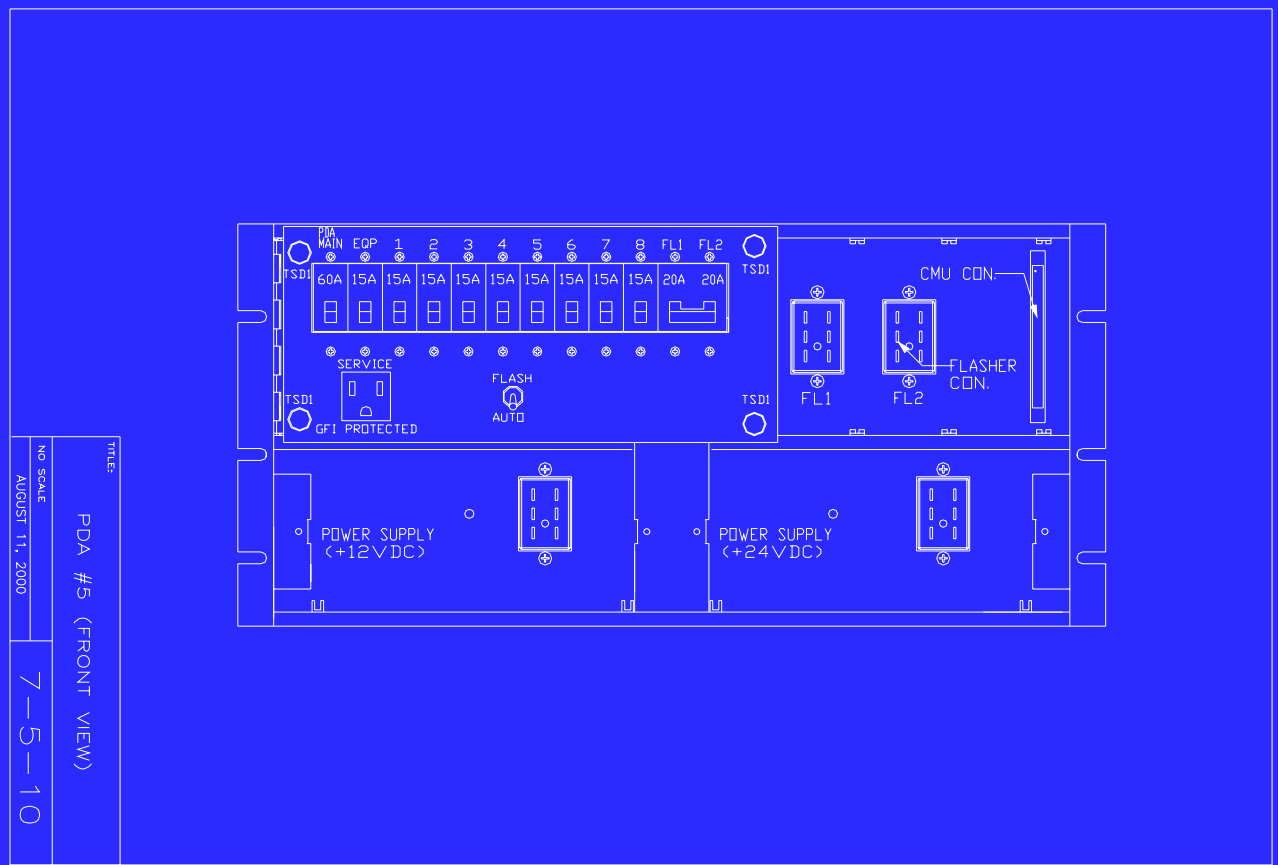
THE CMU, 12 & 24 VOLT POWER SUPPLIES AND FLASHER PLUGS FROM THE FRONT.

PDA #6
PDA #6 REAR IS THE SAME AS PDA #5'S.

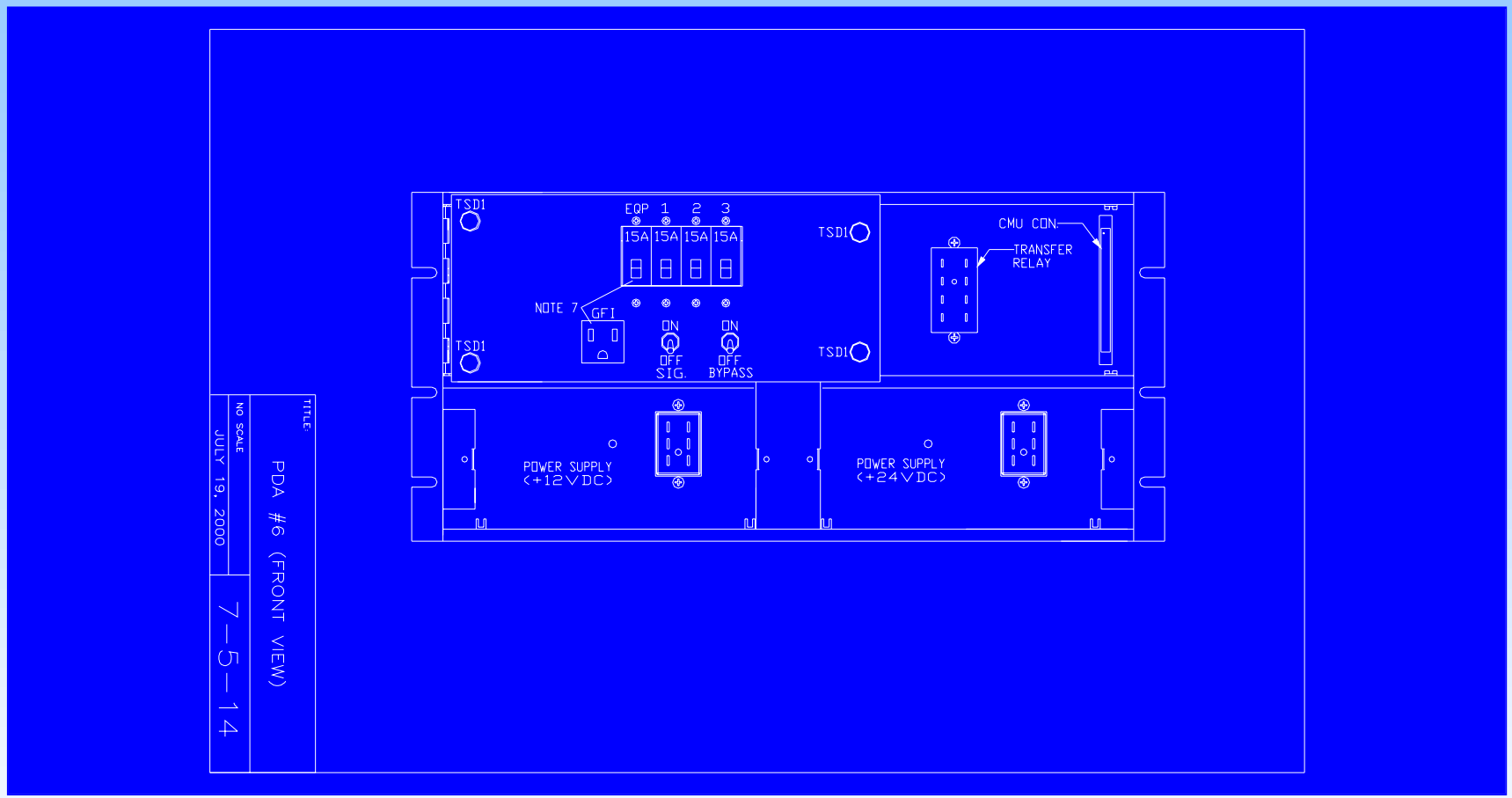
DIFFERENCES ARE:

LESS CIRCUIT BREAKERS, SIMPLER WIRING AND INSTEAD OF HOUSING TWO 204-FLASHERS, IT HOUSES A 430 FLASH TRANSFER RELAY.

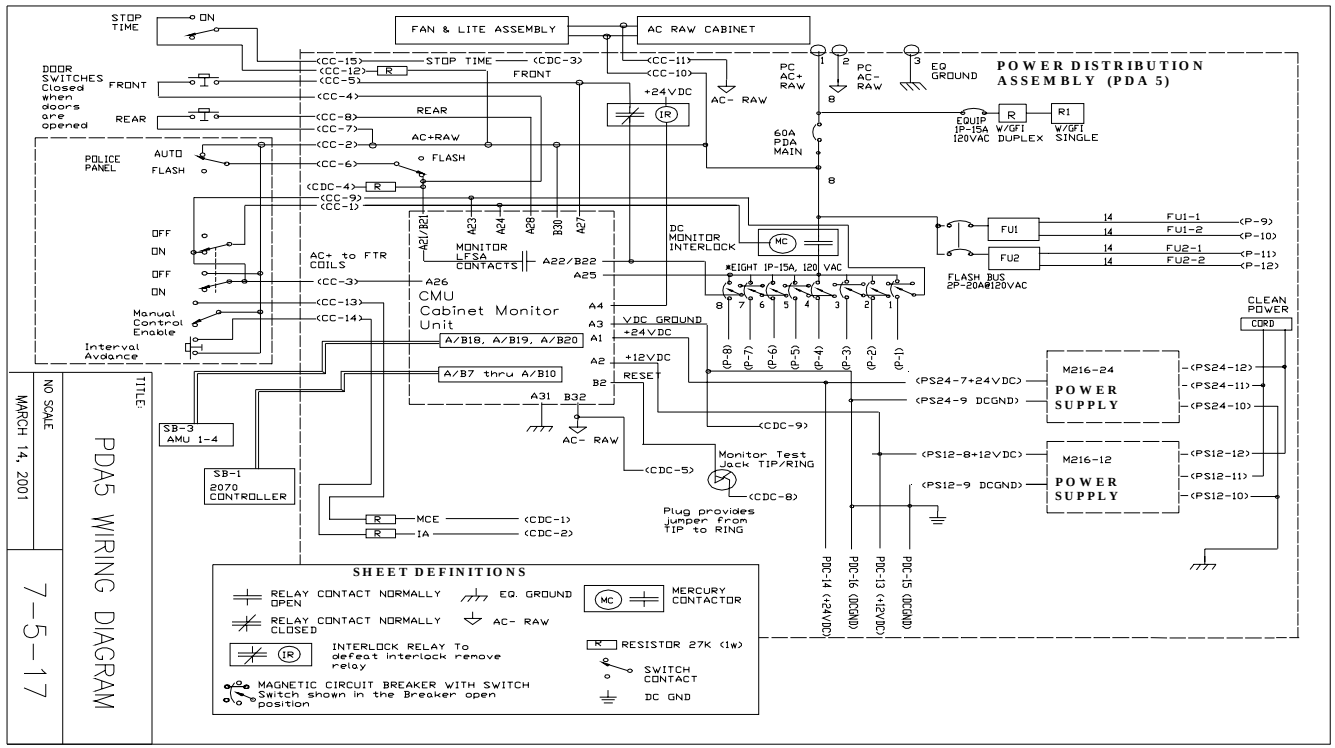
PDA #5


PDA MAIN
EQP
1
2
3
4
5
6
7
8
FL1
FL2
60A
15A
15A
15A
15A
15A
15A
15A
15A
20A
20A
TSDI
TSDI
TSDI
TSDI
SERVICE
GFI PROTECTED
FLASH
AUTO
CMU CON.
FLASHER CON.
FL1
FL2
POWER SUPPLY (+12VDC)
POWER SUPPLY (+24VDC)
TITLE:
PDA #5 (FRONT VIEW)
NO SCALE
AUGUST 11, 2000
7-5-10

PDA #6


TSD1
EQP 1 2 3
15A 15A 15A 15A
TSD1
CMU CON
TRANSFER RELAY
NOTE 7
GFI
ON
OFF
SIG.
ON
OFF
BYPASS
TSD1
TSD1
POWER SUPPLY (+12VDC)
POWER SUPPLY (+24VDC)
TITLE:
PDA #6 (FRONT VIEW)
NO SCALE
JULY 19, 2000
7-5-14

PDA #5 WIRING DIAGRAM
7-5-20



MODULAR BUS ASSEMBLIES

SERVICE PANEL ASSEMBLY: PROVIDES TERMINATION AND THE MAIN BREAKER FOR POLE SERVICE, AND FILTERING BY WAY OF A PLUGGABLE FILTER FOR CLEAN POWER TO THE CONTROLLER AND OTHER ASSEMBLIES.

AC POWER ASSEMBLY: PROVIDES INTERCONNECT OF THE EIGHT CIRCUIT BREAKERS TO THE OUTPUT ASSEMBLIES, FLASHER OUTPUTS AND FTR CONTROL AS WELL AS CLEAN POWER PLUGS FOR RACK ASSEMBLIES.

DC COMMUNICATIONS ASSEMBLY: PROVIDES SERIAL COMMUNICATIONS BETWEEN THE CONTROLLER AND THE SIU MODULES AS WELL AS +24VDC AND +12VDC FOR THE INPUT AND OUTPUT ASSEMBLIES.

AC CLEAN POWER ASSEMBLY: A CLEAN POWER BUS FOR USE IN THE HOUSING 3 RACK ASSEMBLY.

THE MODULAR BUS ASSEMBLIES PROVIDE A SIMPLE QUICK MEANS OF CABINET INTERCONNECT THAT WILL MAKE MAINTENANCE AND TROUBLESHOOTING FASTER AND MORE PRECISE.

SERVICE PANEL ASSEMBLY

AC+ RAW /CLEAN EXTENDED CABLE ASSEMBLY

CABINET COMMUNICATIONS

SERIAL INTERFACE UNIT (SIU) IS THE CABINET COMMUNICATIONS AND CONTROL UNIT

SERIAL BUS 1- COMMAND / RESPONSE, DISTRIBUTED PROCESSING OF OUTPUTS AND STATUS/DETECTION OR STATUS OF INPUTS.

SERIAL BUS 2 - COLLECTOR OF PREPROCESSED DATA FROM DETECTOR DEVICES OR MODULAR NTCIP DEVICES.

SERIAL BUS 3 - DEDICATED TO MONITOR SYSTEM

DC POWER AND SERIAL COMMUNICATIONS BUS ASSEMBLY

SESSION 3.3

ITS CABINET SERIAL BUSES 1 & 2

DAVE MILLER

ITS CABINET SERIAL BUSES 1 & 2 (SB1, SB2)

WHY SERIAL CABINETS ?

General Purpose Instrumentation Rack for:

Traffic	**Ramp**	**Camera**	**Surveillance**
Irrigation	**VMS /DMS**	**Lane Use**	**Rail/Highway**
Speed	**Incident**	**RWIS**	**HAR**
Freeway Lane	**ETC**	**AVI**	**HOV**
Comm Hub	**Violations**	**Weigh in Motion**	**Battery Backup**

SB1 & SB2 PHYSICAL LOCATION

Originates at 2070 ATC Controller

Chemically-bonded CAT5 twisted pairs

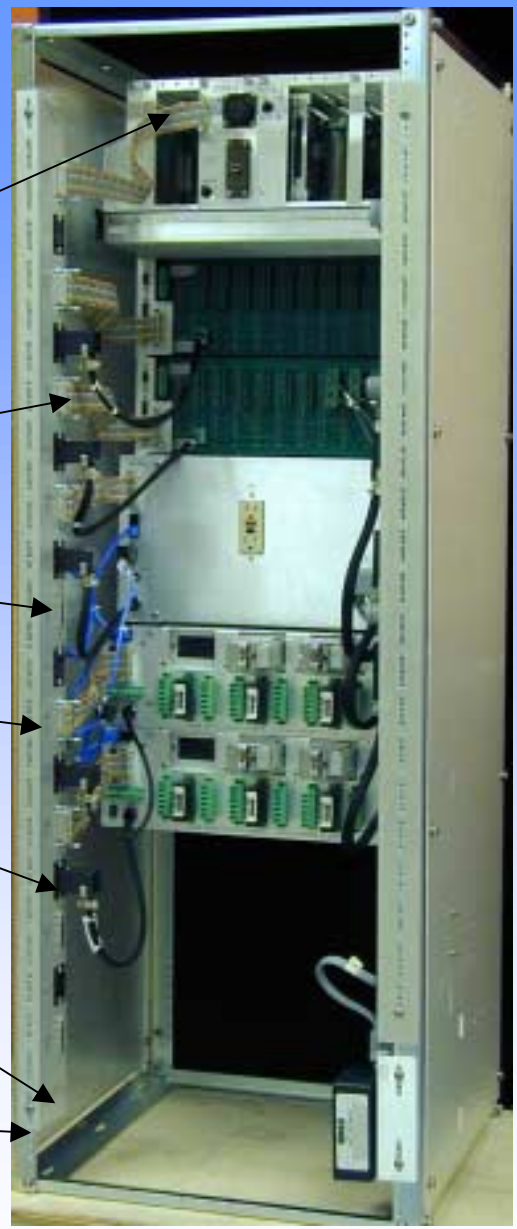
25 pin “D” for each rack location

Removable metal communications bus

+24 VDC and +12 VDC power receptacles

Terminator block at end of SB1 & SB2

Connector for bus expansion below



SB1 & SB2 ELECTRICAL CHARACTERISTICS

- Category 5 (CAT5) twisted pair for TxD, RxD, TxC, RxC
- 25-pin “D” receptacle for each rack position containing both SB1 and SB2 signals in single bundle
- EIA-485 balanced differential signals (DATA & $\overline{\text{DATA}}$)
- SB1 & SB2 originates at controller, ends at terminator block
- EIA-485 distances of thousands of feet with proper cable
- Controller can access I/O in cabinet at remote location

SERIAL BUS 1

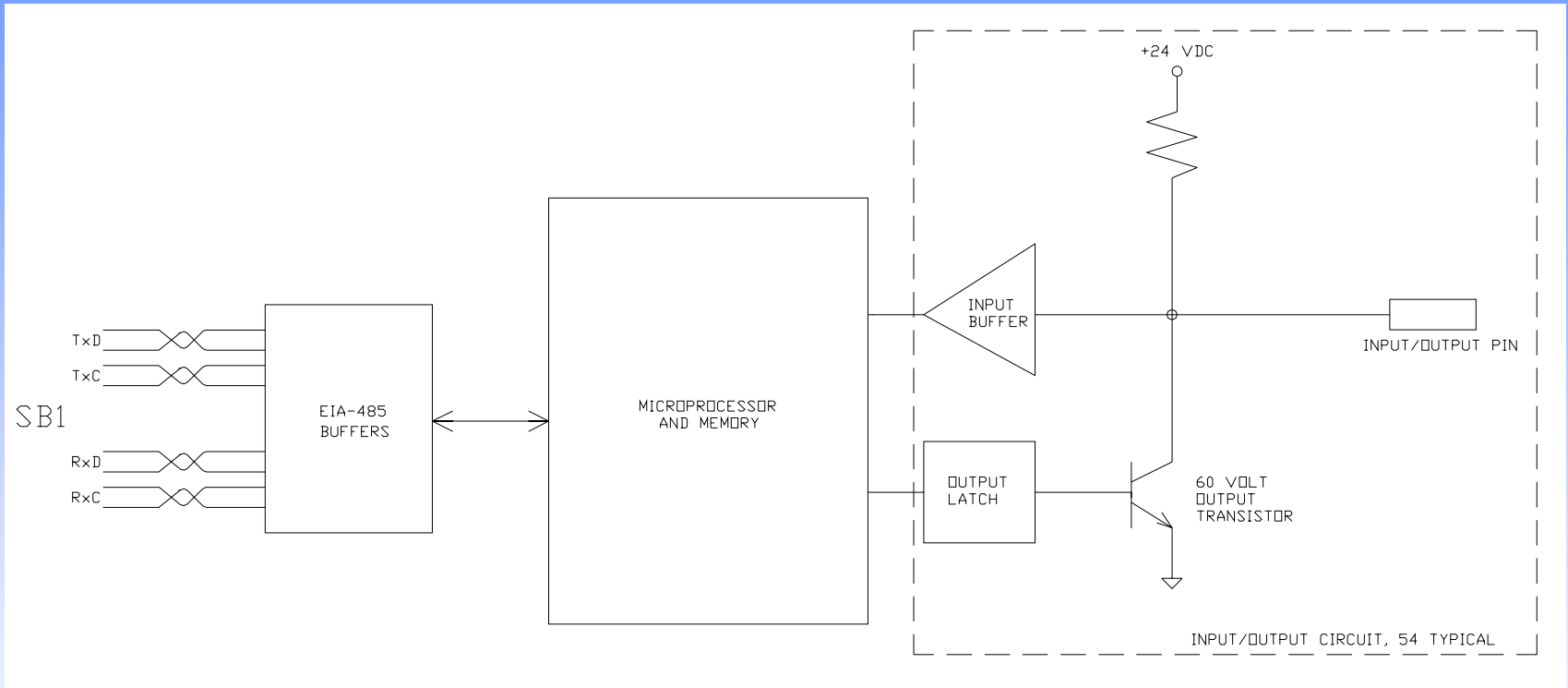
- "Real-time" communications from Controller to I/O
- 614 KBPS communications speed, SDLC frames
- Command / response protocol with CRC and timeouts
- Controller "talks" to all devices in cabinet at once
- Peripheral device "listens" for its address and responds
- Normally used with Serial Interface Units (SIU)
- Same protocol as Field I/O, but at different addresses

SERIAL INTERFACE UNIT (SIU)

SERIAL INTERFACE UNIT (SIU)

- SB1 serial to parallel converter with safety features
- 54 Input/Outputs in each SIU, ground true 24 VDC logic
- Each SIU responds to a unique rack address block
- SIU has microprocessor for input filtering and output mode
- SIU handles 54 detector calls / status or 14 load switches
- 1 mS input resolution for accurate time stamps
- 6 indicator lamps and reset switch for “hot-swap”

SIU BLOCK DIAGRAM



- **Each pin functions as both input and output (1 of 54 shown)**

SIU FUNCTIONAL DESCRIPTION

- All output latches are cleared at power-up
- All output transistors are OFF at power-up
- With output OFF, pin functions as ground true input
- With output ON, pin functions as ground true output, with output state read back on the input buffer
- Output to input “wrap-around” test without cable
- “Mix and match” 54 pins individually as either IN or OUT
- 54 input addresses + 54 output addresses, no map needed

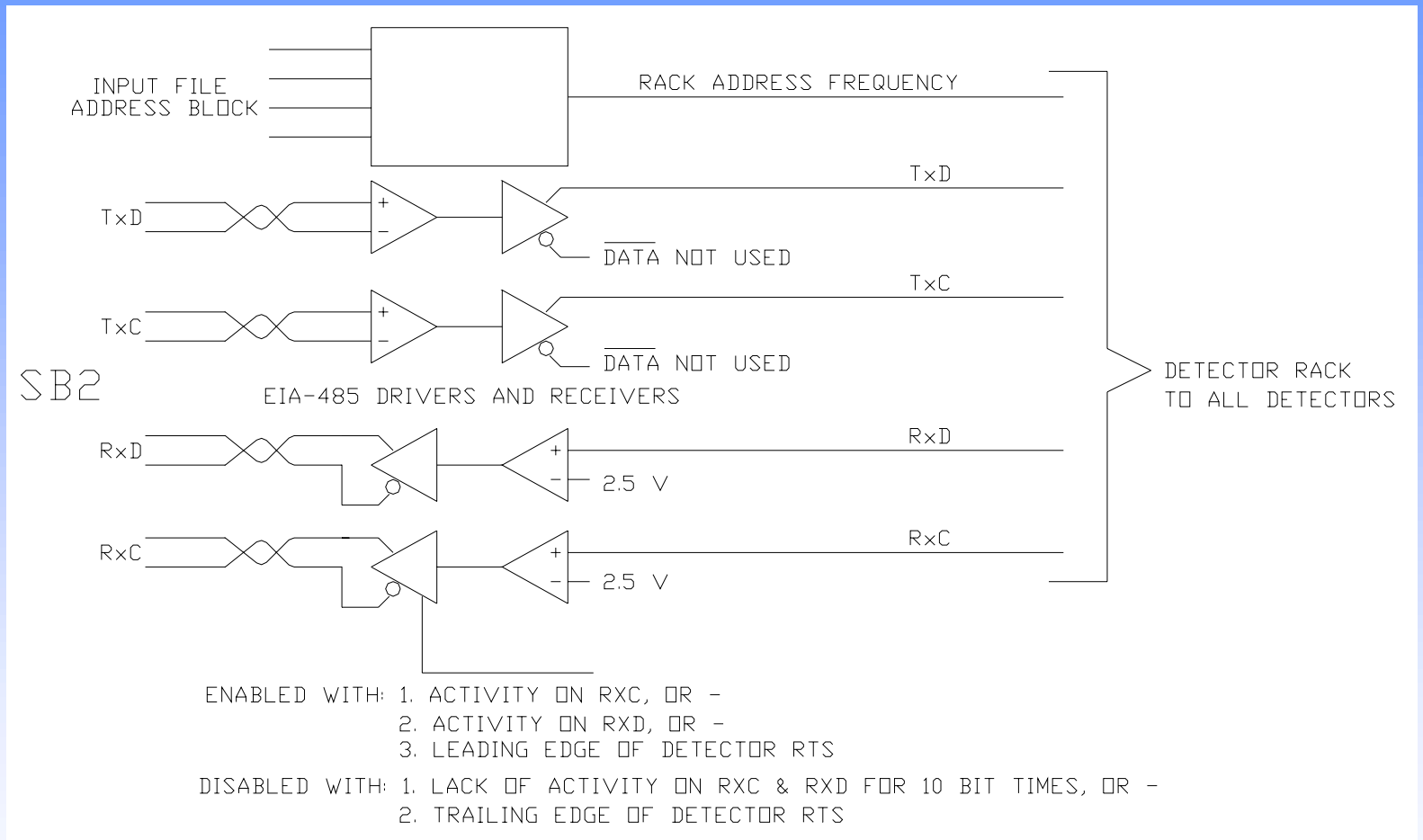
SIU FUNCTIONAL DESCRIPTION (cont'd)

- Inputs are "raw" or "filtered", on command
- Several output modes, such as blinking, pulse
- Offloads processing work from controller to SIU
- 2-second communications loss, outputs OFF
- Monitor checks for "lack of output" versus WDT
- 9-pin EIA-232 connector for future use (reports, firmware)
- Activity lamp under control of user software

SERIAL BUS 2

- **SB2 located in same cabinet 25-pin “D” connector, CAT5**
- **Separate communications channel directly from controller to serial detectors for loop tuning, status, etc.**
- **Used for long “conversational” messages without impacting I/O update performance**
- **Protocol differs with each vendor and hardware device**
- **Software driver comes with each hardware device and is installed on 2070 ATC, similar to PC device drivers**
- **Anticipates future serial detectors other ITS applications**

SERIAL BUS 2 BLOCK DIAGRAM



- **SIU simply provides buffer between cabinet and detectors**

SERIAL BUS 2 OPERATION

- **SB2 is not connected to SIU processor. SIU simply buffers the balanced differential pairs of cabinet SB2 to single-ended driver to detectors.**
- **Controller opens synchronous port if detector is SDLC, or asynchronous if detector is UART with START / STOP bits**
- **Direct connection from applications code to input devices**
- **Compatible with existing serial detectors**
- **Controller "talks" to all detectors at once. Each detector knows what input file and slot it resides in**
- **Only the detector that matches the address frame of the message received from the controller answers back.**

SESSION 3.4

CABINET EMERGENCY SYSTEM & SERIAL BUS #3

CRAIG FEARN

CABINET EMERGENCY SYSTEM

- **TWO CONDITIONS OF ACTION**

  . EXTERNAL CABINET BLANK INDICATION

  . FLASH INDICATION

CABINET EMERGENCY SYSTEM (CONT.)

- **BLANK INDICATION CAUSED BY:**

  . POLICE PANEL ON/OFF SWITCH

  . PDA “MAIN” CIRCUIT BREAKER

  . FLASH TRANSFER RELAY COIL “COLD”

  . FLASHER UNITS NOT INSTALLED

CABINET EMERGENCY SYSTEM (CONT.)

- **FLASH INDICATION CAUSED BY:**

  . POLICE PANEL AUTO/FLASH SWITCH

  . PDA PANEL AUTO/FLASH SWITCH

  . CONFLICT MONITOR UNIT (CMU)

  . FTR COIL FAILURE

  . LOAD CIRCUIT BREAKERS TRIPPED

  . FRONT DOOR CLOSED WITH CMU OUT

SERIAL BUS #3

- **MONITOR SYSTEM BUS**
- **CMU / AUXILIARY MONITOR UNIT (AMU)**

  . DRIVEN BY CMU VIA SDLC PROTOCOL

  . COMMUNICATION USES EIA- 485 STANDARD

SERIAL BUS #3 (CONT.)

- AMU SENSES 2 VOLTAGES AND 2 CURRENTS PASSING BACK STATE CONDITIONS TO CMU UPON COMMAND
- CMU AND AMU ARE NOT VENDOR DEPENDENT

SESSION 3.5

ITS CABINET MONITOR SYSTEM

CLYDE NEEL

Model 212 CMU Versions

	A	B	C	-208	-210
CONFLICTING PHASES	-	F	F	-	F
FLASHER UNIT	-	F	F	-	-
SERIAL BUS #1	F	F	F	-	-
INDICATION ERROR (MULTI/LACK/CLRNC)	-	F	-	-	F*

VERSION: A – RAMP METERING(PDA 6)
B – TRAFFIC SIGNALS(PDA 5)
C – TRAFFIC SIGNALS, "CAL"

-208 – Ver A, w/o SB#1
-210 – Ver C, w/o SB#1

ALL VERSIONS MONITOR:

Power Supplies	Monitor Error	FTR Coils
Logic Signal Error	Flash/Door Switches	AC Line
Circuit Breakers		

PURPOSE

. MONITOR ITS CABINET CONDITIONS
. CAUSE TRANSFER TO SAFE CONTROL MODE
. REPORT DIAGNOSTIC INFORMATION

MONITORING FUNCTIONS

- SIGNAL
  - CONFLICTING CHANNELS
  - MULTIPLE CHANNEL INDICATIONS
  - LACK OF CHANNEL INDICATIONS
  - SHORT/LONG YELLOW
- CABINET POWER SUPPLIES
- SERIAL BUS ERROR

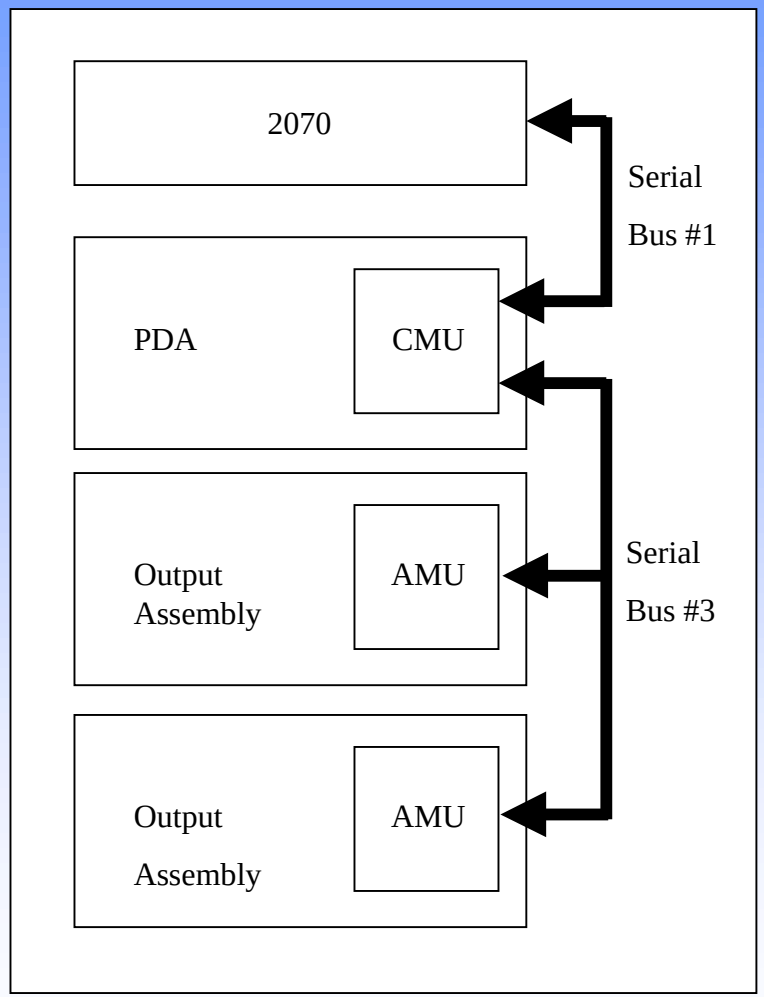
MONITOR FUNCTIONS (CONTINUED)

- MONITOR ERROR
- FLASH TRANSFER RELAY FAILURE
- LOGIC SIGNAL ERROR
- FLASHER UNIT OUTPUTS
- CIRCUIT BREAKER / MERCURY CONTACTOR
- POLICE / PDS FLASH
- AC LINE

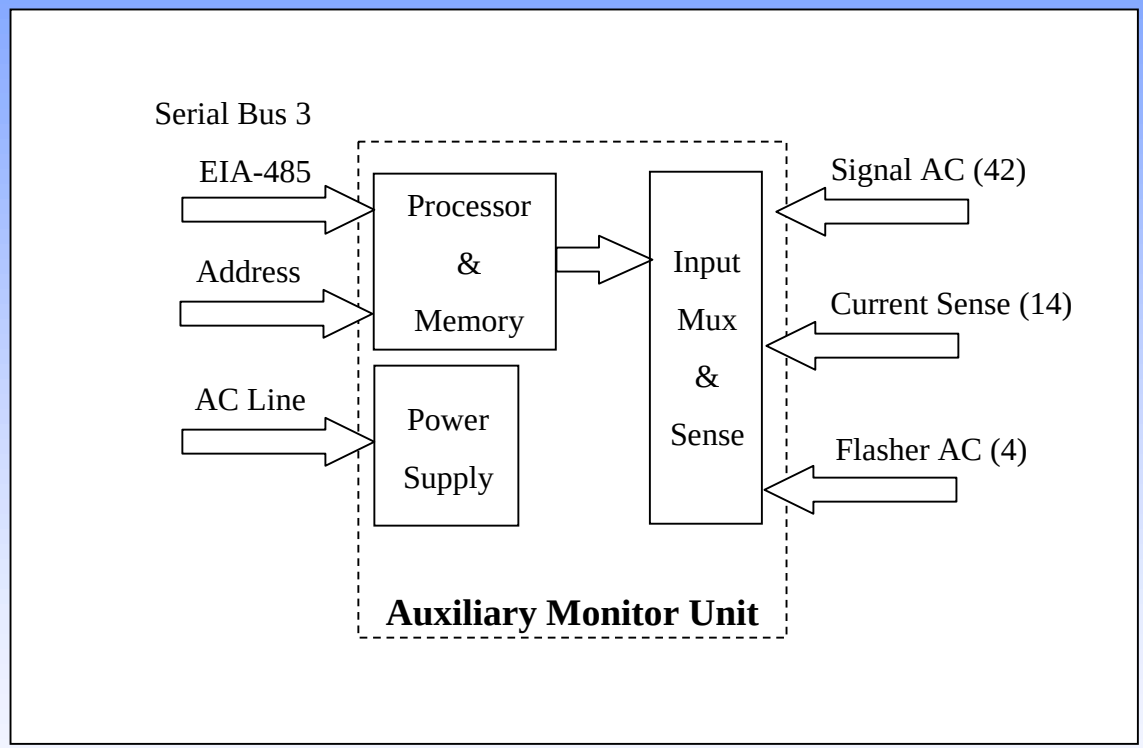
COMPONENTS

- AUXILIARY MONITOR UNIT (MODEL 214 AMU)
- CABINET MONITOR UNIT (MODEL 212 CMU)
- SERIAL BUS #1 AND #3
- CONTROL / SERIAL BUS HARNESSES
- DC POWER / COMM ASSEMBLY
- CURRENT SENSE COILS

MONITOR SYSTEM BLOCK DIAGRAM



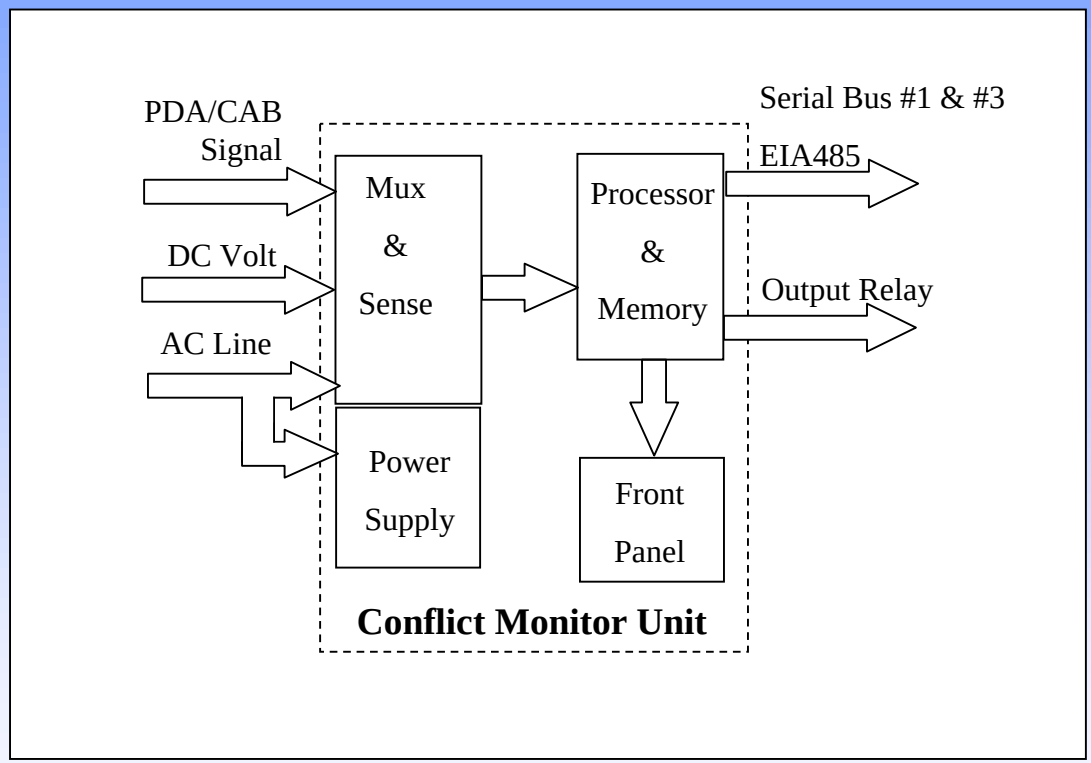
AMU BLOCK DIAGRAM



AMU FRONT PANEL FEATURES

- **INDICATORS**
  - **DC POWER**
  - **COMM ACTIVE**
  - **ERROR**
- **RESET PUSHBUTTON**
- **HAND PULL**

CMU BLOCK DIAGRAM



CMU FRONT PANEL FEATURES

- POWER INDICATOR
- FAULT / STATUS INDICATORS
- DATAKEY
- RESET PUSHBUTTON
- EIA232 SERIAL PORT
- HAND PULL

CMU FAULT / STATUS INDICATORS

- 24VDC
- 12VDC
- CONFLICT
- LACK OF INDICATION
- MULTIPLE INDICATIONS
- CONTROLLER/LOCAL FLASH
- CLEARANCE
- FIELD CHECK
- SB#1 & SB#2 ERROR
- DIAGNOSTIC

DATAKEY PROGRAMMING

- CHANNEL ENABLES/ASSIGNMENTS
- CONFLICTING CHANNELS
- ENABLE MONITORING
  - LACK OF INDICATION
  - MULTIPLE INDICATION
  - SHORT/LONG YELLOW

SESSION 3.6

ITS CABINET DAT VERSION 1.0 PROGRAM

THIS PROGRAM IS A COMBINATION OF THE EAGLE CABINET TEST PROGRAM AND CALTRANS DAT PROGRAM DEVELOPMENT

TARGETED COMPLETION NOVEMBER 2001

MINH V TRAN

ITS CABINET DAT TESTS

- **SERIAL BUS # 1 - COMMUNICATION COMMAND / RESPONSE BETWEEN 2070 CONTROLLER AND I/O ASSEMBLY WITH SIU (SERIAL INTERFACE UNIT) UNIT**
  - **TEST INDIVIDUAL SIU ADDRESS (CHANNEL 1 SIU)**
  - **TEST MULTI-ADDRESSING AS A SYSTEM**
  - **TEST LOOP OUTPUT / INPUT SIU**
  - **TEST SIU TO ASSEMBLY OUTPUT OR INPUT (FIELD CONNECTOR)**
  - **TEST CMU FUNCTIONS**
  - **TEST CMU / EMERGENCY SYSTEM FUNCTION**

ITS CABINET DAT TESTS CONT.

- **SERIAL BUS # 2 - COLLECTOR OF PREPROCESSED DATA FROM DETECTOR DEVICE BETWEEN 2070 CONTROLLER AND INPUT ASSEMBLY WITH SIU (SERIAL INTERFACE UNIT) UNIT**
  - **2070 COMM TO “SMART” DETECTOR ADDRESS VIA SIU (CHANNEL 2)**
  - **MULTI INPUT ASSEMBLY COMM DETECTOR ADDRESS UP TO 5 ASSEMLER OR 60 DETECTOR SENSOR UNITS**
  - **CHECK TIMING AT 19.2 KBPS PER DETECTOR RESPONSE PACKET OF 10 DATA BYTES**

ITS CABINET DAT TESTS CONT.

- **SERIAL BUS # 3 - MONITOR SYSTEM**
  - **AFTER SERIAL BUS #1 TEST OF CMU**
  - **TESTING CMU / AMU INDIVIDUAL ADDRESS**
  - **TEST CMU TO MULT AMU ADDRESSS**
  - **TEST TIMING LOOPS**
  - **TEST AMU SENSING**
  - **TEST CMU PROCESSSING**

SESSION 3.7

CALTRANS ITS CABINET TESTING PROTOTYPE EVALUATION

JEFF FORESTER

ITS CABINET TESTING

- PHYSICAL INSPECTION
- DIAGNOSTIC ACCEPTANCE TESTS
- POWER SUPPLY TESTS
- ENVIRONMENTAL TESTS

PHYSICAL INSPECTION

- ENSURE ALL DELIVERABLES ARE WITH CABINET
- PHYSICAL DIMENSIONS ARE CORRECT?
- MODULES, TERMINAL BLOCKS AND WIRING ARE PROPERLY LABELED? DO THEY MAKE SENSE?
- ENSURE INTERCHANGABILITY BETWEEN MANUFACTURERS
- EVALUATE DIFFERENT HOUSING COATINGS

Graffiti Test

- **Black permanent marker - allowed to stand for several days.**
- **Sprayed with Fantastic All Purpose cleaner.**
- **Wiped off with no residue.**

Input File Test Card

- Tests for proper addressing
- Either 2-channels, or 4-channels
- Switches put call into respective channel

DIAGNOSTIC ACCEPTANCE TESTS

- **BASIC LOOP AROUND PROGRAM (2070)**
  - Tests SIU functionality and proper communications and addressing between inputs and outputs.
- **FULL DIAGNOSTICS**
  - Being developed by Traffic Operations

BASIC SIU TEST PROGRAM

- **Sequences through all output phases, indicated by Light Box**

- **Enabled output is shown on 2070 front panel**

POWER SUPPLY TESTS

- **POWER SUPPLY VOLTAGES AND LOAD TESTING**
  - Line and Load Regulation (90 - 135 VAC / 1 - 5 amps)
  - Efficiency
  - Ripple Noise
  - High and Low Temperature

ENVIRONMENTAL TESTS

- LOAD AND RUN THE CALTRANS TRAFFIC CONTROL SIGNAL PROGRAM (2070)
- TEMPERATURE TESTING AT +74 C AND -37 C
- 2 KVA TEST